Space Weather Technical Forecast

Issued on Monday, 29 July 2024 at 01:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1-G2 / Minor to Moderate Storms Days 1 and 2 (29-30 Jul) with a chance on Days 3 and 4 (31 July and 01 Aug). Isolated R1-R2 Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity remains Moderate, with several M-class flares, the largest, M9.9, peaking at 28/0158 UTC from the complex cluster of regions located in the southeast, likely near AR3766. A further M7.7 flare was observed peaking at 28/1042 UTC from AR3762 in the southwest.

There are currently up to eleven sunspot regions on the visble solar disc. AR3762, in the southwest quadrant, remains the largest and most complex region. It continues to slowly wane in size and no longer displays a delta spot configuration. The cluster of sunspot regions transiting across the southeast quadrant continues to grow in size and complexity, with intricate magnetic looping bringing additional instability. This encompasses AR3765, AR3766 and AR3767. AR3768, in the southwest quadrant, grew significantly, with the appearance of a couple of spots with penumbra. A newly numbered region AR3770 in the northeast is continuing to grow and develop. All other remaining regions appear small, simple and/or largely unchanged. Associated with the M9.9 was a CME, (Coronal Mass Ejection) which likely coincided with possibly as many as two other CMEs around the same time. This has made analysis very challenging. This appears to have an Earth-directed component and an arrival during the second half of the 31 July (day 3) and into day 4 (01 Aug).

A partial halo CME was observed shortly after 27/0600 UTC. It may be attributed to AR3762 since dimming was observed at a similar time but the signal is contaminated by the large far-sided event, resulting in a low confidence analysis with an arrival at Earth due in the next 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, have declined slightly through the period, from 420 km/s to 380 km/s. Density was well below average. The Interplanetary magnetic field, Bt, was weak and remained below 7nT with a slight rise evident late in the period. The north-south component, Bz, was weak and largely positive in the range +5nT to -6nT. The phi angle was predominately positive (away from the Sun). Resulting geomagnetic activity was Quiet (Kp1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 is at background levels. High energy electron flux (greater than 2MeV) observed at GOES16 was at background to moderate levels. The 24-hour fluence was below the Active threshold with an increasing trend. 7.44e6 integrated pfu was observed at 29/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to be Moderate with further M-class flares expected and and chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: Solar winds at low levels until the arrival of the anticipated CMEs when they may reach elevated levels at times (around 550 km/s). Geomagnetic activity Quiet (Kp1-2) at first becoming Active (Kp4) with Minor to Moderate G1/G2 storm conditions for a time on Days 1 and 2 with a slight chance of a Strong Storm (G3). The risk continues into the following couple of days with the arrival of a second CME.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels. However, there is a slight chance of exceeding the S1/Minor Storm threshold should any notable flares occur, most likely from AR3762 in the near term.
The high energy electron flux is forecast to be mostly at background levels. The associated 24-hour fluence is most likely to remain below the Active threshold (1e8 integrated pfu).

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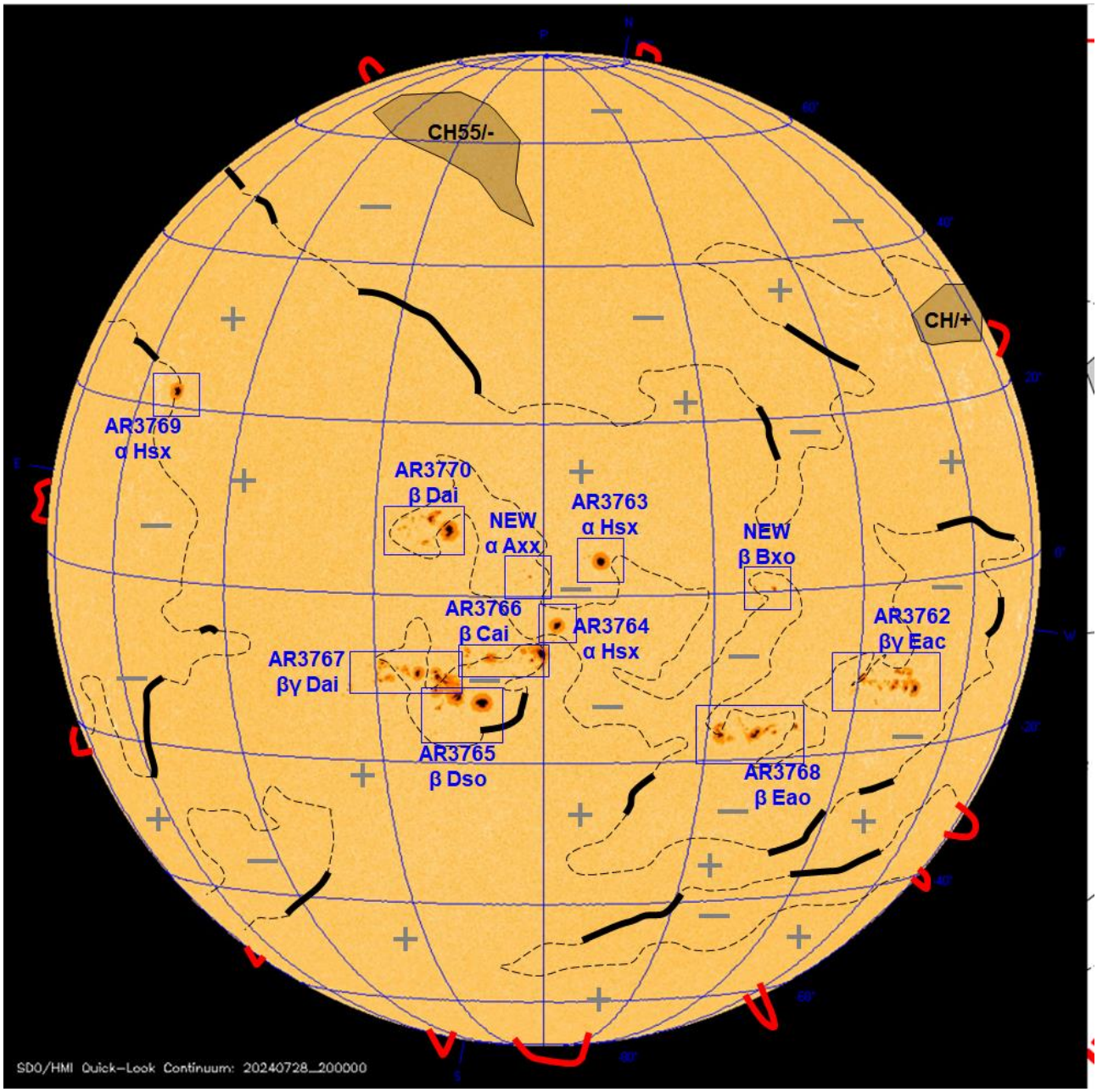
Figure 1. Solar Analysis Valid 2000UTC, 28 July 2024.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Coronal hole HSS (High Speed Streams) feature in this guidance period. A filament lift-off and associated CME from the southern centre disk were observed in coronagraph imagery late on the 26th. This feature was analysed as Earth directed, with an arrival during the next 24 hours. However, the CME that was observed leaving the sun shortly after 27/0600 UTC has been analysed as potentially Earth-directed too. This CME is estimated to travel at a faster velocity and to catch up the first one before it reaches Earth. This gives low confidence in anticipated outcomes.

Current solar winds at slow-ambient levels will respond to the two forecast CME arrivals through the period and this may give elevated levels of solar winds to around 550 km/s. Geomagnetic activity is starting Quiet will probably become Active at times with a 60% probability for G1-G2 Minor to Moderate storm conditions and a slight chance of G3 Strong Storm given the potential for the aforementioned CMEs. The low confidence arrival of a further CME on Days 3 and 4 (31 Jul and 01 Aug) means the chance (40%) of further enhanced geomagnetic activity.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	60	40	40
Strong	G3	No	20	15	1	1
Severe	G4	No	5	5	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/1100	Full	AR3762	NW	870 km/s	29/1500UTC	Low confidence
28/0914	Full	AR3766	SW	500 km/s	31/1200UTC	Very low confidence

Figure 2: Met Office ENLIL ensemble output showing complex CME interaction arrival times.

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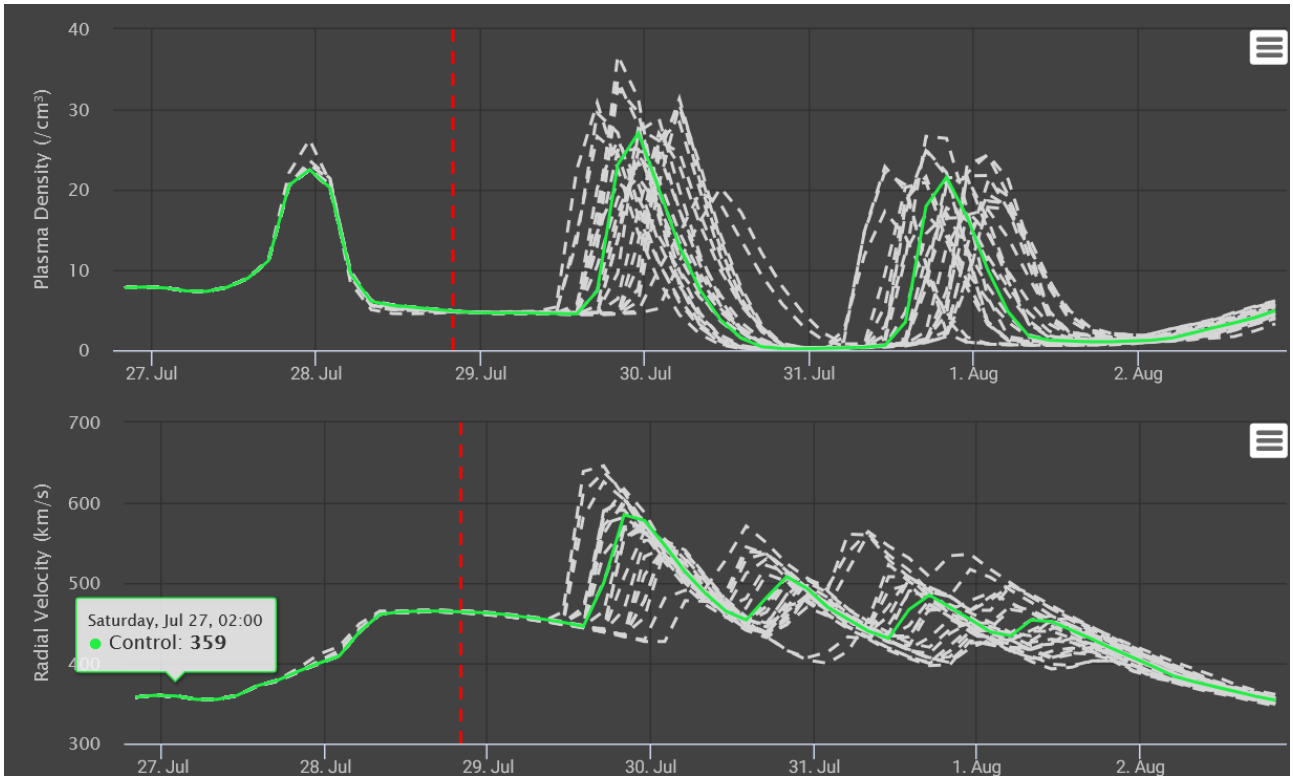

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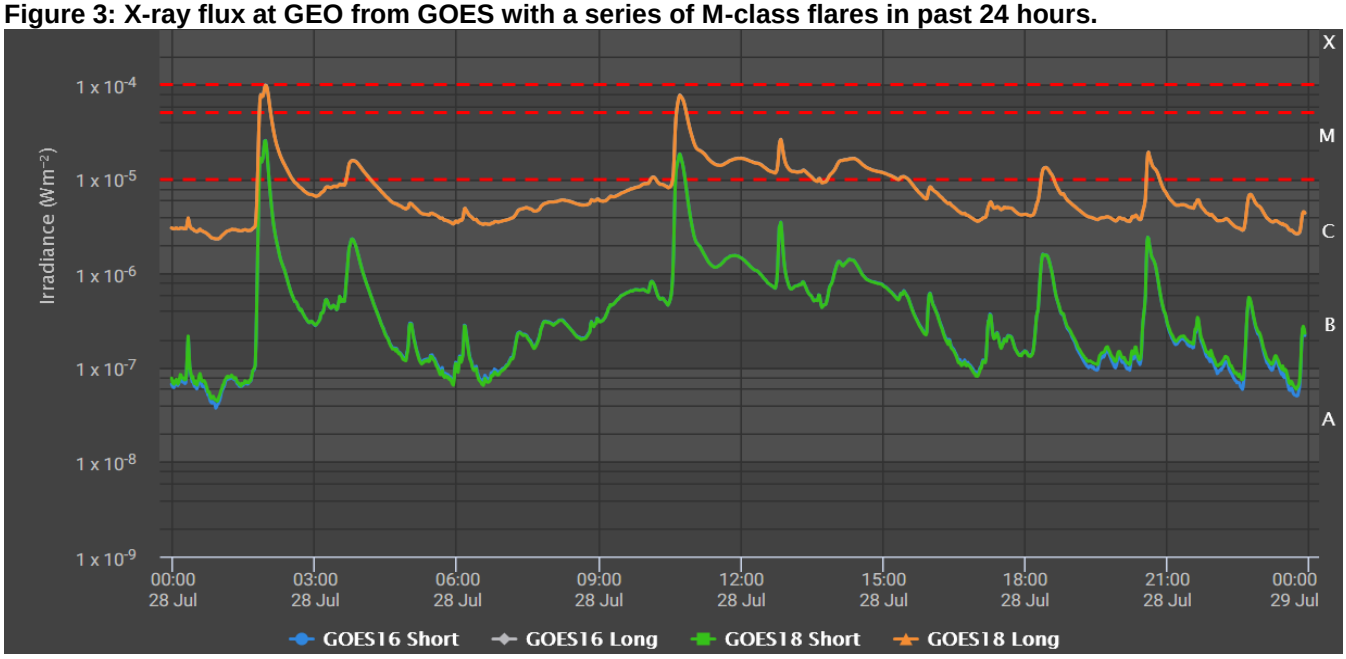
Radio Blackouts - X-Ray Flares:
Eleven sunspot regions cover the visible solar disc. AR3762, in the southwest quadrant, remains the largest and most complex region, but continues to show signs of weakening with the delta spot no longer in evidence. The region immediately to its east, AR3768, continues to develop with some re-organisation of the intermediate and leading spots. The complex cluster of sunspot regions AR3765, AR3766 and AR3767 transiting across the southeast quadrant continues to remain prominent on the disc with some degree of merging of the three separate groups, with intricate magnetic looping bringing additional instability. A new and rapidly growing region in the northeast and approaching centre disc is now numbered AR3770. A returning active region on the far side, as indicated by seismic monitoring, may rotate into view during days 3 and 4. This has produced a series of estimated X-class flares indicated by STIX flare data from Solar Oribiter.

Solar activity is Moderate, with several M-class flares. The largest from AR3766 reaching M9.9 peaking at 28/0157 UTC and an M7.7 peaking at 28/1042UTC, from AR3762. Activity is expected to remain enhanced, with further M-class flares expected. There remains a chance (20%) of isolated X-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	80	80
Very Active	R3 to R5 X Class	No	20	20	30	30

Figure 3: X-ray flux at GEO from GOES with a series of M-class flares in past 24 hours.



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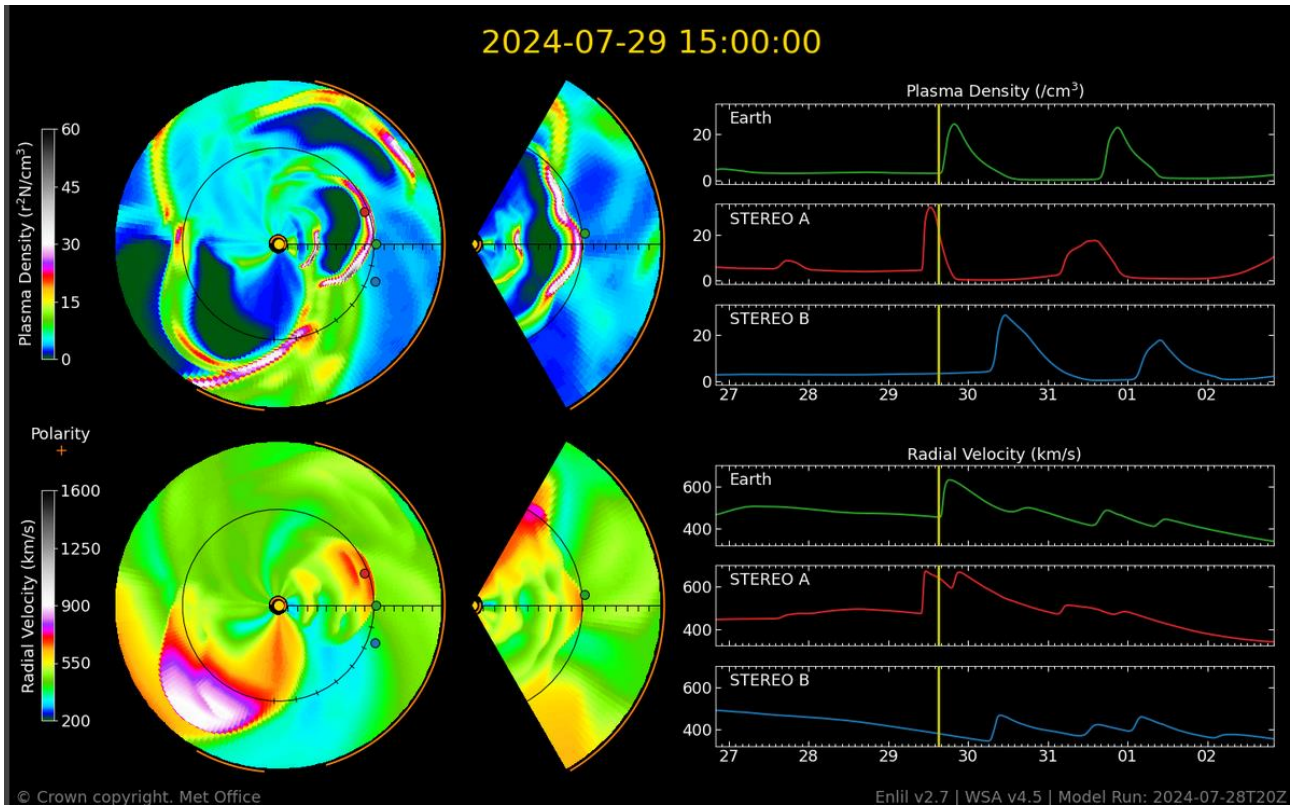
Solar Radiation Storms - (High Energy Protons):
High energy protons are currently at background levels. Proton flux is most likely to remain at background levels, although there is a slight chance of reaching the S1/minor radiation storm threshold, should any notable flare occur. The best candidate is currently AR3762 given its location on the visible disc, the risk considered to increase slightly on Day 3 and Day 4 (30-31 July) when the cluster of active regions is expected to arrive across the southwest quadrant, as well as the significant, flaring, active region due to rotate across the southeastern limb later in this guidance period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Met Office ENLIL output showing arrival of CME in next 24 hours.



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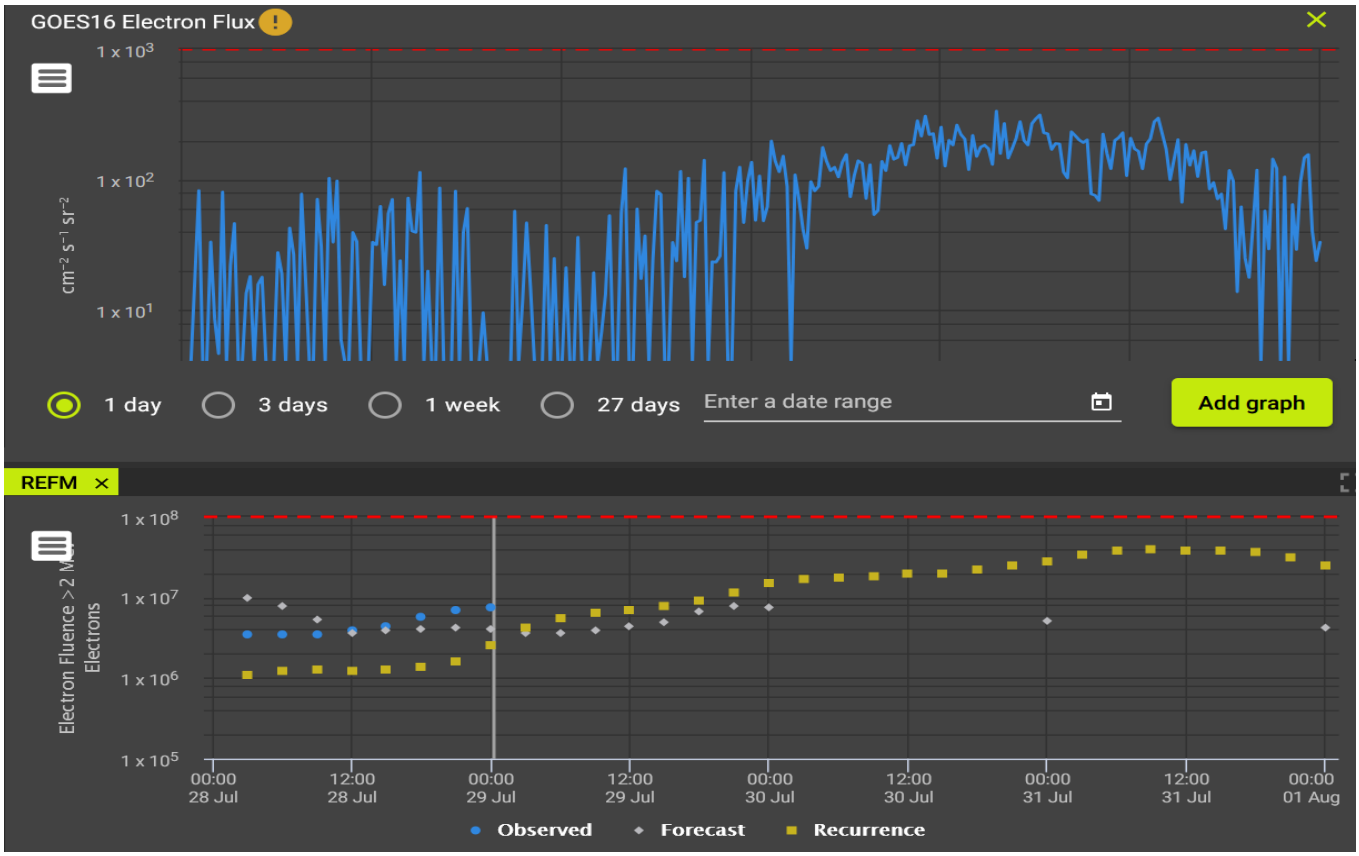
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16, is expected to be at background levels for much of the period. The recent CME and potential fast wind enhancement may have caused an increase in electron flux below GEO, but the potential for further CME arrivals into the period could suppress this once again. Overall, electron flux is most likely to stay at background levels, but as the solar wind speeds decline there is the possibility of an increase to peak at moderate levels at times as has been observed in the past 24 hours.

The associated electron fluence is most likely to persist below the Active threshold (1e8 integrated pfu). The latest MOSWOC REFM output is forecasting a rising trend below Active, which is viewed as relatively good guidance though with lower than usual confidence given the potential for further CME influence.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	10	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: High energy electron flux at GEO and latest Met Office REFM output.



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